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RABIES, a disease which affects both animals and men, has been present in all parts of the world except Australia, New Zealand, and some of the Pacific Islands. Ever since the dawn of civilization descriptions of this disease have appeared in medical literature. In his treatise, "The History of Animals," Aristotle wrote extensively on canine madness.

The close relationship between man and his dog which has grown through the ages has prevented in a large measure the eradication of rabies in many parts of the world. The disease has thus been allowed to continue and spread to all the populated areas of the world. Opposition to quarantine measures restricting the freedom of dogs has made it difficult to eradicate rabies in the United States. There are few other diseases which can be so easily controlled by sanitary measures as rabies. Vectors other than the dog have played but a minor part in the propagation of this disease in North America. Rabies, then, is largely confined to urban areas where dogs are allowed to roam the streets with no restriction. In such communities when rabies is introduced, it is likely to assume epizootic proportions.

Many efforts have been made to eradicate or control rabies in local communities. Such efforts have resulted in the elimination of this disease from many communities, but because of the absence of any restrictions on the movement of animals from infected areas rabies has eventually been reintroduced. The elimination of rabies from any region requires the combined action of everyone concerned with this problem. Today the U.S. Public Health Service is stimulating concerted action throughout the United States for the purpose of eradicating rabies.

## The Epidemiology of Rabies

Before the discovery of the causative agent of rabies, control measures for this disease were possible only through effective quarantine. The first areas to eradicate rabies by means of strict quarantine measures were the Scandinavian countries in the nineteenth century. Denmark, Sweden and Norway have remained free of rabies since then due to the enforcement of an extended quarantine period for all imported dogs. Rabies was eradicated from Great Britain about 1900 but was reintroduced in 1918. However, by 1922 the disease had again been eradicated. Since that time no further epizootics of rabies have occurred. Great Britain enforces a six-month quarantine for animal pets entering the country. During World War II there was no report of rabies being introduced into the British Isles although many animals entered with the allied armies. It is significant that 16 dogs developed rabies while under quarantine detention in Great Britain from 1919-1939. One dog that was held beyond the six months quarantine because of a history of exposure to rabies developed the disease after 6 months and 24 days in quarantine. There are reports of incubation periods up to 25 months. Australia and New Zealand also have the six-month quarantine provision which has been effective in keeping rabies out of these countries.

The incidence of rabies in the United States had increased in the last decade up to 1946. The following table shows the reported cases of rabies in animals and

man in the United States from 1938 through 1947. These statistics were compiled by the Bureau of Animal Industry of the United States Department of Agriculture.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Animals | 9365 | 8284 | 7210 | 7847 | 7137 | 9649 | 10487 | 9928 | 10850 | 8920 |
| Year | 1938 | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | 1945 | 1946 | 1947 |
| Man | 47 | 30 | 28 | 30 | 28 | 41 | 53 | 35 | 22 | 26 |
| Total | 9412 | 8314 | 7238 | 7877 | 7165 | 9690 | 10540 | 9963 | 10872 | 8946 |

With few exceptions the cases reported in these animals have been diagnosed by laboratory examination. In some states where there is more than one central laboratory the figures are not complete. No doubt the true incidence of the disease is considerably higher than the one reported.

Climate and season have no influence on the spread or maintenance of rabies. The disease has been reported in Alaska and other arctic areas. It is also known to exist in tropical areas all around the world. Epizootics of rabies may occur at any time of the year. The geographical distribution of rabies has been associated with the migration of man and animals from one place to another and the movement of men and animals during war.

### Immunity to Rabies

Pasteur was the first to show that fixed rabies virus could be inoculated subcutaneously into dogs without producing infection, and with repeated injections the animal became highly resistant to experimental infection, even to intercerebral injections of virus. Other research men found that the intraperitoneal injections of large amounts of fixed virus produce a good degree of immunity.

Immunity nowadays is largely due to the subcutaneous inoculation of a vaccine produced from rabies-infected brain tissue in which the virus has been inactivated by phenol or chloroform. The phenol treated virus is known as a killed virus vaccine and is referred to as the Semple vaccine. The chloroform treated virus was described by Kelser in 1930 as an inactivated virus vaccine. There is no evidence that the immunity produced by the phenol or chloroform killed vaccine is due to the presence of a small amount of living virus. Vaccines properly prepared and approved for antigenic content will remain antigenic for at least one year after they have shown to be devoid of infectivity.

There are a number of new vaccines which are being tested in the field and will be reported on in the near future. These include the ultra-violet attenuated rabies vaccine and the chick embryo vaccines.

The phenol-killed virus, or Semple vaccine, was first described by Semple, while he was working in India in 1911, as a vaccine for rabies in man. This vaccine is used extensively for human protection in many parts of the world today. It can be made up and kept for a considerable length of time before used. Its use is much simpler and more economical than the vaccines containing living virus.

In order to prevent the development of rabies in man following exposure to the disease, it is essential to establish the equivalent of intracerebral resistance as the immunity produced must prevent the multiplication of the virus in the nervous system. It is not necessary in the case of dogs to produce as high a degree of immunity to prevent the spread of the disease, as the exposure in dogs is usually peripheral, and when animals are properly immunized the rabies virus will be inactivated before the nervous system is invaded. Johnson studied post exposure treatment in dogs and found that treated and control dogs developed the disease with the same frequency for the first month following exposure. After the first month there were no deaths among treated dogs but the control animals continued to develop the disease.

### Rabies in Dogs

Rabies occurs most frequently in dogs. The symptomatology of canine rabies

has been described by numerous authors. The continuity of the disease in this species is furthered by the instinctive fighting and biting nature of such animals. When dogs contract rabies they usually become extremely aggressive against their own kind as well as all other living things they encounter. The occasional long incubation period allows the virus to survive in relatively few animals from year to year. In places where the dog population reaches large numbers, the disease may become epizootic. Usually, however, there is a low incidence of rabies.

The incubation period in dogs may vary from 10 days to several months. The longest incubation period observed was reported by Argentine investigators who have had dogs in quarantine for over two years before rabies developed. In most instances rabies will develop from 21 to 60 days after exposure. The distance that the rabies virus must travel from the peripheral exposure to the brain does not appear to vary the time of the incubation period. In experimental animals the incubation period is related in length to the amount of virus injected.

Rabies in dogs is classified as the furious or the dumb type according to the symptoms shown by the animal. In the furious type the excitation phase is very distinctive and usually prolonged, whereas in the dumb type the paralytic phase develops early with depression and apathy. The majority of cases show some phases of both types of the disease. There may be a short excitatory period followed rapidly by depression and paralysis. During acute epizootics sudden death due to rabies among dogs without obvious symptoms is frequent. The number of cases of furious and dumb rabies that may occur is not constant, but depends on the virulence of the virus and the species of animal infected.

Wild animals that become rabid lose their fear of man and human habitation and will invade urban communties and attack man and domestic animals. Wild animals are seldom observed when they are victims of dumb rabies as they probably die in seclusion.

**Rabies Control**

In order to have an effective program of rabies control in the United States, a program must be coordinated on a national scale. In view of the fact that the disease is maintained solely in animals, primarily the dog, control work is a veterinary public health problem. The Public Health Service is coordinating a national rabies eradication program with the state departments of health. The states, in turn, are stimulating rabies control work in the county and municipal health departments.

Rabies control work on a state basis should be under the supervision of a full-time health veterinarian. Rabies in animals is in most cases a reportable disease; new cases are reported immediately to the state health department and weekly to the United States Public Health Service. Past experience has shown that the disease is apt to be of epizootic proportions in a given locality before the state authorities responsible for rabies control are aware of the outbreak. The heads of all domestic and wild animals suspected of having rabies should be submitted for examination whether or not there was human exposure to the disease. Wherever rabies is found to exist in wild life species, the state health department should notify the U. S. Fish and Wild Life Service as well as the State Wild Life (Conservation) Department, so that a cooperative control program may be developed. The public veterinarian in cooperation with the health educator should promote an educational program so as to inform the public as to the hazards of rabies and measures necessary for its control.

Taxation and licensing of dogs is recommended as the most effective means for insuring enforcement of rabies control regulations. The traditional rabies control program is one which requires strict quarantine for all dogs for a period of six months after the last reported cases of rabies. It is necessary to maintain the quarantine for an extended period but in most instances this has failed to eliminate the disease in this country because the public failed to

cooperate. Field experience has shown that vaccination of all owned dogs, carried on in conjunction with collecting and impounding of unvaccinated dogs found at large, has brought about the elimination of rabies. This method of rabies control has been used effectively in several foreign countries as well as in many communities in the United States.

Compulsory vaccination of dogs for rabies on a state-wide basis has been difficult to enforce. Alabama has had such a law since 1937 but it was not possible to enforce this law in the two most heavily infected regions of the state until 1945, due to the fact that enforcement was delegated to each county board of health, and local opposition prevented action until such opposition could be convinced that the procedure was necessary. In Massachusetts vaccination of dogs has been encouraged on a voluntary basis and has been adopted throughout the state without resorting to legal action to make it compulsory. For the first time since the introduction of the disease in the eighteenth century, this state is free of the disease.

Vaccination of dogs combined with other dog control provisions is the most satisfactory method for accomplishing prompt recession of the disease. It is recommended that a strict quarantine for all dogs be enforced for at least 30 days as soon as rabies appears in the community. Subsequently dog owners should be required to have their pets vaccinated or keep them confined until the area is officially certified free of rabies. Vaccinated dogs, properly tagged, may be allowed at large 30 days after vaccination. Vaccination should be done on a clinic basis in order to obtain maximum cooperation. A single subcutaneous injection of 5 ml. or more of an approved vaccine should be required, but dog owners should be advised that a course of three weekly injections of vaccine will produce a more certain immunity to rabies. Dogs under 6 months of age, which are particularly susceptible and not readily immunizable, should be kept confined until the area is officially certified free of rabies. Biting dogs and suspected rabid dogs should be impounded for a period of at least 14 days. Dogs known to have been exposed to rabies must be destroyed or kept confined for a six-months period.

These methods of rabies control will not be successful unless there is adequate provision that unvaccinated dogs and stray dogs will be picked up promptly. Investigation of each new case and contact case is essential. The enforcement of a temporary quarantine for all dogs will facilitate greatly the impounding of stray dogs and the vaccination of owned dogs until rabies is eliminated from all of our states. It is wise to practice annual vaccination of all dogs. The disease is apt to be introduced from time to time. In cities it is practical to require a dog owner to show a current vaccination certificate prior to the issuance of a dog license. Dogs found on the street without a dog license should be considered as unvaccinated and impounded.

Statistics on rabies for the United States indicate that domestic cats are infected frequently. The bite of a rabid cat is probably more dangerous than that of a dog. While rabies prevails in a community, it is wise for cat owners to have their pets vaccinated by the three-injection method. Stray cats should be impounded and destroyed.

If rabies becomes established among wild animals, it is necessary to carry out a program of reduction of the number of the affected species until the disease disappears. It is evident that the heads of animals taken in this type of program should be examined for rabies so as to determine the incidence of the disease and when it has abated.

### Eradication of Rabies

Rabies can be eradicated. The epidemiology and epizoology of the disease is known. There are no insect vectors to contend with, the virus does not live outside the body and we have effective immunizing agents. It is up to the local veterinarian to put it into effect in every community. The eradication of rabies will be one of the greatest contributions of veterinary medicine to public health.